5-1997

Optx20/20™ and Press-On Optics™ bifocal segments: An evaluation

Stacy M. Bell
Pacific University

Kristin J. Gurholt
Pacific University

Optx20/20™ and Press-On Optics™ bifocal segments: An evaluation

Abstract

Background: Press-On Optics™ and OPTX 20/20™ removable bifocal segments were evaluated in three areas: optical quality, effects on vision, and stability under simulated environmental conditions.

Methods: OPTX 20/20™ segments -generate optical power using smooth front and back surfaces with differential radii; Press-On Optics™ segments use Fresnel groves. To evaluate optical quality of the segments, sphere, cylinder, and spherical equivalent powers were measured in center, right, and left portions of 10 segments of each type with powers of + 1.00, + 1.50, +2.00 and +2.50 D. A Data Optics Ann Arbor Distortion Tester was used to grade optical distortion in the central portion of each segment and across the entire segment. To evaluate the effects on vision, monocular near visual acuity and contrast sensitivity were measured while 23 subjects wore +2.00 D Press-On Optics™, OPTX 20/20™, and molded CR-39 segments. To evaluate the effects of environmental conditions, plano CR- 39 carriers with mounted segments were heated to 140° F (60° C), cooled to oo F (-18° C), subjected to a water stream, and exposed to intense light.

Results: With regard to optical characteristics of the segments, 12 out of 20 OPTX 20/20™ segments and 6 out of 20 Press-On Optics + 1.00 and + 1.50 D segments failed to pass ANSI ophthalmic lens standards because of unwanted cylinder powers of -0.25 to -0.50 D. Marked powers of the OPTX 20/20™ segments were significantly more accurate than those of the Press-On Optics™ segments. OPTX 20/20™ segments produced substantial distortion near their upper edges, but the implications of this distortion for wearability are unknown. In their central portions, higher power OPTX 20/20™ segments typically produced less distortion and had better optical characteristics than did the Press-On Optics™ segments. With regard to vision, +2.00 D OPTX 20/20™ segments provided a one Snellen line advantage in near acuity as compared to the Press-On Optics™ segments for a majority of subjects. Contrast sensitivity for low and mid-spatial frequencies was not significantly different for +2.00 0 OPTX 20/20™ or Press-On Optics TM segments. All of the segments retained their attachments to CR-39 carriers during heating, cooling, and water stream tests. Following prolonged exposure to intense light, optical transmission decreased by 7% for the OPTX 20/20™ segments and 2% for the Press-On Optics™ segments.

Conclusions: Both the OPTX 20/20™ and Press-On Optics™ segments have relative advantages and disadvantages. For higher powers, the optical characteristics of the OPTX 20/20™ segments are better and provide better visual acuity. For lower powers, distortion and small amounts of unwanted cylinder reduce the optical quality of the OPTX 20/20™ segments. It is unknown whether the cylinder and distortion are of sufficient magnitude to produce asthenopia if the segments were used for extensive near

Degree Type

Thesis

Degree Name

Master of Science in Vision Science

Committee Chair

Robert L. Yolton

Keywords

bifocal, temporary bifocal, optx 20/20, press-on optics, data optics ann arbor distortion test, distortion

Subject Categories

Optometry

OPTX 20/20™ AND PRESS-ON OPTICS™ BIFOCAL SEGMENTS: AN EVALUATION

By

STACY M. BELL
KRISTIN J. GURHOLT

A thesis submitted to the faculty of the
College of Optometry
Pacific University
Forest Grove, Oregon
for the degree of
Doctor of Optometry
May, 1997

Advisors:

Robert L. Yolton, O.D., Ph.D.
W. Thomas Griffith, Ph.D.

SIGNATURE PAGE

Authors:

Stacy M Bell

Stacy M. Bell

Kristin J. Gurholt

Advisors:

Robert L. Yolton, O.D., Ph.D.

W. Thomas Griffith, Ph.D.

ABOUT THE AUTHORS

Stacy M. Bell was born and raised in Merced, California. She studied molecular biology and biochemistry at San Jose State University before transferring to Pacific University where she graduated with a Bachelor's Degree in Visual Science in 1994. While in optometry school, Stacy was president of the local Student Optometric Association and an active member of Optometric Extension Program, Beta Sigma Kappa International Honor Society, and American Academy of Optometry. During her second year, she was selected for the Army Health Professions Scholarship. Stacy is a candidate to receive her Doctorate of Optometry Degree and Masters Degree in Education, Visual Function in Learning in May, 1997. After fulfilling her military obligation, Stacy plans to pursue a career in private practice specializing in pediatric optometry and vision therapy.

Kristin J. Gurholt was born in Cambridge, Minnesota and spent most of her growing years in Bismarck, North Dakota. In 1992, she graduated with an Associate of Science from Bismarck State College with emphasis on Chemistry and Mathematics. She continued her studies at University of North Dakota and began optometry school at Pacific University in the fall of 1993. She received the Bachelor's Degree of Visual Science in 1995 and anticipates her Doctor of Optometry degree in May, 1997. Kristin continues to enjoy hiking, biking, and politics as she endeavors to practice primary care with emphasis on geriatrics and vision therapy.

Background: Press-On Optics™ and OPTX 20/20™ removable bifocal segments were evaluated in three areas: optical quality, effects on vision, and stability under simulated environmental conditions.

Methods: OPTX 20/20™ segments generate optical power using smooth front and back surfaces with differential radii; Press-On Optics™ segments use Fresnel groves. To evaluate optical quality of the segments, sphere, cylinder, and spherical equivalent powers were measured in center, right, and left portions of 10 segments of each type with powers of +1.00, +1.50, +2.00 and +2.50 D. A Data Optics Ann Arbor Distortion Tester was used to grade optical distortion in the central portion of each segment and across the entire segment.

To evaluate the effects on vision, monocular near visual acuity and contrast sensitivity were measured while 23 subjects wore +2.00 D Press-On Optics™, OPTX 20/20™, and molded CR-39 segments.

To evaluate the effects of environmental conditions, plano CR-39 carriers with mounted segments were heated to 140° F (60° C), cooled to 0° F (-18° C), subjected to a water stream, and exposed to intense light.

Results: With regard to optical characteristics of the segments, 12 out of 20 OPTX 20/20™ segments and 6 out of 20 Press-On Optics +1.00 and +1.50 D segments failed to pass ANSI ophthalmic lens standards because of unwanted cylinder powers of -0.25 to -0.50 D.

Marked powers of the OPTX 20/20™ segments were significantly more accurate than those of the Press-On Optics™ segments.

OPTX 20/20™ segments produced substantial distortion near their upper edges, but the implications of this distortion for wearability are unknown. In their central portions, higher power OPTX 20/20™ segments typically produced less distortion and had better optical characteristics than did the Press-On Optics™ segments.

With regard to vision, +2.00 D OPTX 20/20™ segments provided a one Snellen line advantage in near acuity as compared to the Press-On Optics™ segments for a majority of subjects. Contrast sensitivity for low and mid-spatial frequencies was not significantly different for +2.00 D OPTX 20/20™ or Press-On Optics™ segments.

All of the segments retained their attachments to CR-39 carriers during heating, cooling, and water stream tests. Following prolonged exposure to intense light, optical transmission decreased by 7% for the OPTX 20/20™ segments and 2% for the Press-On Optics™ segments.

Conclusions: Both the OPTX 20/20™ and Press-On Optics™ segments have relative advantages and disadvantages. For higher powers, the optical characteristics of the OPTX 20/20™ segments are better and provide better visual acuity. For lower powers, distortion and small amounts of unwanted cylinder reduce the optical quality of the OPTX 20/20™ segments. It is unknown whether the cylinder and distortion are of sufficient magnitude to produce asthenopia if the segments were used for extensive near work. However, for occasional near tasks, this should not be a problem.

Both segment types retained adhesion to CR-39 carriers equally well and should be satisfactory for their designated purposes of providing temporary and removable adds for occasional use.

KEY WORDS: Bifocal, temporary bifocal, OPTX 20/20™, Press-On Optics™, Data Optics Ann Arbor Distortion Test, distortion, vision, optics, optometry.

Prior to 1995, the only readily available temporary use bifocal segments were made by 3M, Inc. and marketed under the trade name Press-On Optics™[e]. The segments make use of Fresnel optics which create optical power by using grooves cut or pressed into a plastic membrane. Use of Fresnel optics allows relatively high power lenses to be very thin and light, but the grooves can degrade visual acuity due to light scattering and chromatic effects.[1,2]

Problems associated with using Fresnel optics include an inherent reduction in high-spatial frequency contrast sensitivity caused by the lens groves and the accumulation of dirt and debris in the grooves. To address these problems, Neoptx, Inc., introduced a new type of press-on bifocal segment called OPTX 20/20™[f]. The segments are made using a cast-molded, high index plastic that relies on differential front and back surface radii to create optical power (i.e., they have smooth front and back surfaces). Characteristics of the Press-On Optics™ and OPTX 20/20™ segments are shown on Table 1.

Insert Table 1 About Here

OPTX 20/20™ segments are currently being marketed to professionals and the public. They come in a unique package that allows the segments that are mounted in a protective plastic carrier to be pulled from their cardboard container and evaluated by potential purchasers. Using this system, individuals can select appropriate segments by trying several powers. Packaging for Press-On Optics™ and OPTX 20/20™ segments is shown on Figure 1.

Insert Figure 1 About Here

Potential Applications

A press-on bifocal segment can fulfill many needs for presbyopes with special occupational requirements or hobbies. Perhaps the most obvious is application to plano eyeware such as sun glasses, ski goggles, and impact protection lenses. These segments can allow a presbyopic fisher or skier to see details well enough to read, tie on fishing lures, or adjust ski bindings without removing sunglasses and putting on lenses with molded adds. The segments can also be used to customize safety glasses for multiple users. For example, press-on segments can be quickly and easily added to plano "visitor glasses" given to persons touring manufacturing areas with eye hazards.

Optometric uses of temporary segments include the evaluation of segment powers and heights for new presbyopes or those with unusual working distances. Presbyopes with special occupations or hobbies that require unusual segment shape or sizes can also be fit with press-on segments that are cut to suit the patient's particular needs. For example, presbyopic electricians with short-term jobs that require overhead work might find it practical and cost-effective to use a temporary segment rather than having a special pair of lenses made with permanent segments.

For post-op cataract or presbyopic photorefractive keratectomy patients, temporary segments could also be used until the eye had stabilized enough to prescribe a permanent lens. Still other applications involve providing temporary or trial adds to vision therapy patients, especially those with accommodative esotropia[3], latent hyperopia[4], or reading problems.

Project Goals

The potential applications of temporary segments are realistic only if the segments provide good optics and are mechanically stable. The purpose of this study was to evaluate and compare the OPTX 20/20™, Press-on Optics™, and molded CR-39 bifocal add segments in three areas: optical properties including dioptric powers and distortions, effects on visual acuity and contrast sensitivity, and effects of simulated environmental conditions on the segments.

METHODS AND RESULTS

Segment Application Procedure

The segments were applied to 6.00 D base curve plano CR-39 lens carriers using the following procedure. First, the segment and carrier were sprayed with a dilute solution of oil-free Joy™ dish washing liquid and rinsed completely in a tray of distilled water. They were then submerged in fresh distilled water and the segment was pressed onto the carrier's back surface with pads of the thumbs. After the segment was firmly in place and all air bubbles had been pressed out, exterior surfaces were blotted with Kim-wipes. The carrier-segment combination was then allowed to air dry at room temperature until interference fringes were no longer visible (at least 40 min).

Optical Characteristics

To compare optical characteristics, production-run segments were mounted on plano CR-39 lens blanks as described above. An automated lensometer was used to determine optical powers at multiple locations on each segment, and an Data Optics Ann Arbor Distortion Tester[9] was used to evaluate the degree of distortion produced by the segments.

Lensometry

Ten OPTX 20/20™ and 10 Press-On Optics™ segments with powers of +1.00, +1.50, +2.00, and +2.50 D were mounted on CR-39 plano carriers that were free from any measurable sphere or cylinder power. An Alcon Renaissance Auto Lens Analyzer was then used to measure optical power at the center of each segment, 8 mm to the right of center, and 8 mm to the left. Sphere, cylinder, and spherical equivalent powers were determined at each location accurate to the nearest 0.12 D. Results of these measurements are shown on Table 2.

Insert Table 2 About Here

For segments with manufacturers' marked powers of +1.00 and +1.50 D, the actual mean spherical equivalent power of the OPTX 20/20™ segments was significantly more accurate than the mean power of the Press-On Optics™ segments (t-test, $p<0.05$). There were no statistically significant differences for the other segment powers.

Uniformity of power across the segments was determined by comparing center, right, and left spherical equivalent powers. There were no significant differences between the means of these measurements for any of the segment types or powers (repeated measures analyses of variance, $p>0.05$).

Comparison to ANSI Standards

Although no specific ANSI standards are known to exist for temporary add segments, perspective can be obtained by comparing the lensometry data from the segment centers to the ANSI Z80.1-1995 standard for prescription ophthalmic lenses[5]. This standard requires that lenses with marked powers up to 6.50 D have variations of no more than plus or minus 0.13 D.

Using this standard, a significant number of the lower power OPTX 20/20™ segments and a lesser number of Press-On Optics™ segments failed to pass because of cylinder powers ranging from -0.25 to -0.50 D (Table 3). For the OPTX 20/20™ segments with cylinder, axes tended to cluster around 180 degrees for the center portions of the lenses, around 135 degrees for the left portions, and around 45 degrees for the right portions. No particular pattern of cylinder axes was noted for the Press-On Optics™ segments.

Insert Table 3 About Here

Distortion Testing

Distortion is produced by aberrations that yield unequal powers at different points on a lens. In the case of OPTX 20/20™ segments, distortion can result from variations in the thickness of the segment, surface irregularities, or inhomogeneities in optical indices at different locations within the segment. For the Press-On Optics™ segments, these problems can also occur along with variations in the spacing and angles of the Fresnel grooves. Small amounts of distortion are usually well tolerated by the visual system but larger amounts can cause reduced acuity and asthenopia.

To assess distortions produced by the segments, an Data Optics Ann Arbor Distortion Tester (DOAADT) was used.[9] The DOAADT consists of an illuminated Ronchi grating which produces an image that is projected through the lens being tested. The image of the grating is then reflected back to combine with the image of the original grating to form a Moiré fringe pattern. Distortion is revealed by bending or by alterations in the thickness and spacing of the fringes.

Ten OPTX 20/20™ and 10 Press-On Optics™ segments with powers of +1.00, +1.50, +2.00, and +2.50 D were used for distortion testing. Each of these 80 segments was mounted on a plano CR-39 carrier which had previously been determined to be distortion-free. Distortions produced by the segments were graded by using a modification of the US Army Visor Distortion Standard (MIL-V-43511C)[h]. This Standard was developed for assessing the optical quality of protective visors and has only pass or fail categories. To allow more precise grading of distortion, the pass or fail categories were expanded into 5 grades based on increasing amounts of distortion. Categories 1 through 3 would pass the Standard and categories 4 and 5 would fail. Photographs illustrating the five category grades of distortion are shown in Figure 2.

- -

Insert Figure 2 About Here

- -

The degree of distortion was first graded by considering the most distorted area of the central portion the segment excluding the 2 mm wide peripheral zone. Next, the maximum distortion for the entire segment was graded. The use of two grades was necessary because the peripheral zones typically showed a much larger degree of distortion than did the central zones. Results of these determinations are shown on Tables 4 and 5. To provide perspective for these results, molded CR-39 +2.00 D segments were given a grade of 1 for both central and over all distortion.

- -

Insert Tables 4 and 5 About Here

- -

In almost all cases, distortion was most noticeable when the entire segment was evaluated. This was especially true for the OPTX 20/20™ segments because many of them had a significant degree of distortion near the top edge where they had been cut during the manufacturing process. Maximum distortion for the Press-On Optics™ segments typically occurred below the center of the segment. Figure 4 shows examples of distortion produced by typical +2.00 D Press-On Optics™ and OPTX 20/20™ segments.

- -

Insert Figure 3 About Here

- -

Effects on Vision

To determine how use of the segments would affect the vision of persons using them as spectacle adds, acuities and contrast sensitivity functions were determined for a group of normal subjects using +2.00 D segments. This power was selected because it was strong enough to reveal any inherent optical problems with the segments, but it was not so strong as to compromise near visual acuity for non-presbyopic subjects.

Near Visual Acuity

Twenty-three young adult subjects (mean age 25.9 years, SD 2.6, range 23 to 32 years) gave informed consent to participate in this project. All had near visual acuities of at least 20/20 for the right eye either uncorrected or corrected with contact lenses. Subjects also had 20/20 or better near Snellen acuity through a +2.00 D corrected curve trial lens. Acuities were determined using a Second Edition Lighthouse Acuity Card[i] held at 40 cm. Monocular measurements were made to avoid any confounding effects of convergence or other binocular phenomena produced by a +2.00 D add.

To determine the effects of the segments on vision, near visual acuity was assessed while each subject viewed the Lighthouse card through a plano CR-39 lens with a molded +2.00 D ST-28 segment, and through +2.00 D OPTX 20/20™ and +2.00 D Press-On Optics™ segments mounted on plano CR-39 carriers. Lenses were presented in a random order with 3 different Lighthouse Card versions were used to prevent memorization. To ensure that subjects used only the add portion of the lens, their left eyes were patched, and their right lenses were occluded except for the segment portion.

Acuity measurements were converted to LogMAR values for calculation proposes. Extrapolations were made between LogMAR values based on the number of letters read or missed in each Snellen line (i.e., each of the five letters in a line were worth 20% of the LogMAR value for the line on which they appeared). Mean LogMAR and calculated Snellen equivalent acuities for the molded, OPTX 20/20™, and Press-On Optics™ segments are shown on Table 6.

Insert Table 6 About Here

Statistically, mean visual acuity was significantly lower using the Press-On Optics™ segments than it was with the molded or OPTX 20/20™ segments. Mean acuities measured through the OPTX 20/20™ and molded segments were not significantly different from each other. (Statistical comparisons were made using a repeated measures analysis of variance with a significance level of 0.05, and a post-hoc Scheffe test with a significance level of 0.10.)

To provide a somewhat more clinically meaningful indication of the segments' effects on near acuities, Snellen acuities, extrapolated to the nearest line, were also determined. Using this procedure, the subject was given credit for the line only if 3 or more of the 5 letters on the line were read correctly. Using the Lighthouse card and +2.00 D powers, acuities were compared for the three segment types on a subject by subject basis. Table 7 shows number of subjects whose acuities differed by a line or more.

Insert Table 7 About Here

Near Contrast Sensitivity

To assess the effects of segments on low and mid-spatial frequency sensitivity, a Vistech MCT 8000 Near Contrast Sensitivity Testj was used. The test was administered following manufacturer's instructions using recommended illumination levels and test plates held 40 cm from the subject. Each of the 23 subjects viewed a test plate monocularly through the molded, OPTX 20/20™, and Press-On Optics™ +2.00D segments presented in a random order. To avoid memorization of the grating orientations, three different plates were used in a random sequence for each subject.

Results of contrast sensitivity testing are shown on Figure 4. Repeated measures analyses of variance indicate that there is no significant difference in contrast sensitivity between segment types for any of the spatial frequencies tested ($p>0.05$).

Insert Figure 4 About Here

Environmental Effects On Lenses

Segments that are applied to sun glasses or ski goggles must be able to withstand extremes of heat and cold by retaining their dimensional stability, transparency, and adhesion to the carrier lenses. To evaluate these factors, segments mounted on plano CR-39 carriers were subjected to heat, cold, a water spray, and an intense light containing a high proportion of ultraviolet in its spectrum.

Heat and Cold

Four Press-On Optics™ and 4 OPTX 20/20™ segments with powers of +1.00, +1.50, +2.00, and +2.50 D, respectively, were applied to eight plano CR-39 carriers and allowed to dry for at least 6 hours. The carrier-mounted segments were then placed in a 140° F (60° C) oven for 10 hours. An additional set of 4 Press-On Optics™ and 4 OPTX 20/20™ segments mounted on CR-39 carriers were placed in a freezer at 0° F (-18° C) for 10 hours.

To test adhesion, the carriers with attached segments were each dropped on their edges 5 times onto a hard surface from a height of 4 inches (10 cm) just after being removed from the oven or freezer. None of the segments were displaced from their carriers as a result of this treatment; all remained firmly in place.

After the segments and carriers had cooled or warmed for at least 2 hours, powers were determined for the central portions of the segments using a lensometer. None of the segments showed spherical equivalent power changes of greater than 0.25 D as compared to their pre-exposure values.

Water Spray

Four Press-on Optics™ and 4 OPTX 20/20™ segments with powers of +1.00, +1.50, +2.00, and +2.50 D were applied to plano CR-39 carriers and allowed to dry for 2 hours. Each was then subjected to an 8 liter per minute flow of 70° F (21° C) tap water applied at a 45 degree angle to the segment from a kitchen sink sprayer for 5.0 min. The carriers were then dropped on their edges from a height of

4 inches (10 cm) onto a hard surface. All of the segments maintained their original positions on the carriers throughout the water stream and dropping procedure.

Exposure to Intense Light

Two OPTX 20/20™ and 2 Press-on Optics™ segments with powers of +2.00 D were applied to plano CR-39 carriers and sent to a laboratory for Weatherometer testing.[k] This test consists of exposing the carriers with mounted segments to an intense light containing a high proportion of ultraviolet in its spectrum. Following 240 hours of exposure, none of the segments had lost adhesion to their carriers, but some of the OPTX 20/20™ lenses had darkened slightly. After this exposure, transmission across the visual spectrum decreased by approximately 7% for the OPTX 20/20™ segments and 2% for the Press-On Optics™ segments. These reductions cannot be attributed to the CR-39 carriers because segments were removed for transmission testing.

Segment Application and Removal

Because the segments are designed to be removed and reused, the effects on optical power of repeated removal and replacement were evaluated. To do this, 6 Press-on Optics™ and 6 OPTX 20/20™ segments (2 each with powers of +1.00, +2.00, +2.50 D) were applied to CR-39 carriers and allowed to dry for 2 hours. A measurement of central spherical equivalent power was then made using an Alcon automatic lensometer, and central distortion was evaluated using the DOAADT for each segment. Following this, all segments were removed and re-applied 5 times at 2 hour intervals.

After the final application, lensometry and distortion grading were repeated and results compare to the initial measurements. For all of the segments, optical powers were essentially unaffected by the 5 cycles of application/removal. By the end of the fifth cycle, 3 of the OPTX 20/20™ segments had increased in distortion by at least one grade, and 4 of the Press-on Optics™ segments had small opacities, but these effects disappeared after allowing the segments to dry for 48 hours.

DISCUSSION

The goal of this study was to evaluate the OPTX 20/20™ segments and compare them to Press-On Optics™ segments. The most obvious difference between the segment types is their methods of creating optical power: the OPTX 20/20™ uses differential front and back surface radii of curvature, whereas the Press-On Optics™ segments use Fresnel grooves. Potentially, the smooth surfaces of the OPTX 20/20™ segments should provide better optical characteristics than the grooved surfaces of the Fresnel segments, but at the expense of requiring thicker segments.

Unfortunately, this potential was somewhat compromised for the 1.00 and 1.50 D OPTX 20/20™ segments by the manufacturing process that created distortion near the upper edges, and cylinder power in the central portions of the segments. For 2.00 and 2.50 D OPTX 20/20™ segments, distortion and cylinder were less of a problem and the 2.00 D OPTX 20/20™ segments provided better high spatial frequency sensitivity (i.e., better Snellen visual acuity) than did the Press-On Optics™ segments. For mid- and low-spatial frequency contrast sensitivities, there were no difference between the segment types. Based on these results, both segment types could be used for temporary near viewing, but many patients will definitely appreciate the optical characteristics of the OPTX 20/20™ segments (i.e., the lack of grooves), especially when higher powers or prolonged near work are required.

With respect to mechanical adhesion and ease of application/removal, there were no significant differences between the segment types. Both OPTX 20/20™ and Press-On Optics™ should maintain adhesion and initial optical quality under a variety of environmental conditions and are reusable for at least 5 renewal/replacement cycles.

In optometric practice, removable segments warrant consideration for use as specialty lenses or temporary bifocals to help in determining segment heights or powers. However, with regard to tasks that require extended periods of near work, it is unknown whether patients can wear either type of segment comfortably. The distortion and cylinder in the low power OPTX 20/20™ segments could cause asthenopia, and the reduced near acuity and annoyance caused by the Fresnel grooves might limit use of Press-On Optics™ segments. A study addressing this issue is currently underway.

Corresponding Author:

Robert L. Yolton, Ph. D., O. D.

Pacific University

College of Optometry

Forest Grove, OR 97116

ACKNOWLEDGMENTS

We thank Dr. Karl Citek, Pacific University College of Optometry, for helpful discussions on optics; Dr. William McLean, USAARL, Fort Rucker AL, for information on the DOAADT and other assistance; and Mr. Harold Moody, US Army Natick Research Development and Engineering Center, for conducting the Weatherometer tests. We also thank Neoptx, Inc. and Beta Sigma Kappa for grants which made possible the equipment used in this project. These acknowledgments do not necessarily imply acceptance of or agreement with any of the statements made in this paper by the individuals or organizations acknowledged. The authors have no financial interest in any of the organizations that supplied funding for this project, nor did any of the authors receive personal financial compensation from these organizations. Design of the project, analysis of the results, and preparation of this report were solely determined by the authors.

FOOTNOTES

a. Items of equipment used in this project including OPTX 20/20™ and Fresnel lenses, CR-39 lens blanks, and a Data Optics Ann Arbor Distortion Testing Device were supplied through grants from Neoptx, Inc. and Beta Sigma Kappa.

b. Fourth year optometry students, Pacific University

c. Faculty, Pacific University College of Optometry

d. Faculty, Pacific University Colleges of Optometry, and Arts and Sciences

e. Neoptx, Inc. 2205 152nd Ave NE, Redmond, WA 98052 1 (800) 662-2460

f. Franel Optical Supply Co., 111 Atlantic Dr. 32751, PO Box 940096, Maitland, FL 32794. 1 800-327-2070

g. Data Optics Ann Arbor Distortion Tester, Model E. Data Optics Inc., 115 Holmes Rd., Ypsilanti MI 48198-3020.

h. MIL-V-43511C US Army Visor Distortion Standard. US Army Natick Research Development and Engineering Center, Natick MA, 01760-5014.

i. The Lighthouse Inc., 111 East 59th St., New York, NY 10022. 1 800 334-5497.

j. Vistech Consultants, Inc., 1372 N. Fairfield Rd., Dayton OH, 45432.

k. Testing was conducted by Mr. Harold Moody at the US Army Natick Research Development and Engineering Center, Natick MA, 01760-5014. The Weatherometer test is described in ASTM G 26093, Method 4. During the test, samples are exposed to the output from a xenon lamp passed through two borosilicate filters. The total integrated irradiance applied during the test was 1120 Watts/m^2

with the light passed through the carrier-segment combination from the carrier side. Twenty hours of exposure were provided per 24 hour cycle, and 10 cycles were run to complete the test sequence.

REFERENCES

1. Adams AJ, Kapash RJ, Barkan E. Visual performance and optical properties of Fresnel membrane prisms. Am J Optom 1971; 48:289-97.
2. Woo GC, Campbell FW, Ing B. Effect of Fresnel prisms dispersion on contrast sensitivity function. Ophthal Physiol Optics 1986; 6(4):415-18.
3. Flom MC. Treatment of binocular of vision. In: Hirsch MJ, Wick B, eds. Vision of children. Philadelphia: Chilton, 1963:197.
4. Flom MC, Adams AJ. Fresnel optics in clinic ophthalmology. In: Duane TD, Jaeger EA, eds. Clinical ophthalmology, vol 1. Hagerstown, MD: Harper and Row, 1982:1-15.
5. American National Standard for Ophthalmics - Prescription Ophthalmic Lenses - Recommendations. 1995. Optical Laboratories Association. PO Box 2000, Merrifield VA. 22116-2000.

Table 1. Characteristics of OPTX 20/20™ and Press-On Optics™ segments as of Spring 1996

Characteristic	OPTX 20/20™	Press-On Optics™
Material	Polyurethane	Polyvinyl Chloride
Optical Principle	Differential Front and Back Surface Curvatures	Fresnel Grooves
Thickness	Depends on Segment Power; Center Thickness Ranges From Approximately 1.25 mm for +1.00 D to Approximately 1.50 mm for +2.50 D	1.0 mm
Optical Index	1.58	1.525
Segment Type	D-30	D-25
Range of Powers	+1.00 to +3.00 D in 0.25 D Steps	+1.00 to +3.00 in 0.50 D Steps; Also +4.00, +5.00 and +6.00 D With Compensating Prism Power
Method of Adhesion	Molecular Bond to Carrier	Molecular Bond to Carrier
Wholesale Cost per Pair	$12.00	$15.50
Source for Segments Used in This Study	Neoptx, Inc. 2250 152. Ave NE Redmond WA 98052	Franel Optical PO Box 9400 Maitland FL 32794

Table 2. Mean powers for 10 lenses of each power and type (total of 80 lenses) as determined by an automated lensometer. All segments were mounted on plano CR-39 carriers prior to measurement. Values in parentheses are standard deviations.

		Mean Powers Measured in Center Portion of Segment			Mean Powers Measured on Right Portion of Segment			Mean Powers Measured on Left Portion of Segment		
Marked Segment Power	Segment Type	Sphere	Cylinder	Spherical Equivalent	Sphere	Cylinder	Spherical Equivalent	Sphere	Cylinder	Spherical Equivalent
+1.00 D	OPTX 20/20	+1.097 (0.0780)	-0.199 (0.147)	+1.012 (0.025)	+1.072 (0.0619)	-0.124 (0.118)	+1.012 (0.025)	+1.121 (0.0589)	-0.224 (0.0983)	+1.012 (0.025)
+1.00 D	Press-On Optics	+0.96 (0.120)	-0.012 (0.0379)	+0.928 (0.104)	+0.909 (0.103)	-0.049 (0.0865)	+0.878 (0.095)	+0.985 (0.0926)	-0.024 (0.0506)	+0.985 (0.088)
+1.50 D	OPTX 20/20	+1.461 (0.0627)	-0.174 (0.134)	+1.372 (0.043)	+1.396 (0.0548)	-0.024 (0.0506)	+1.384 (0.51)	+1.448 (0.0671)	-0.148 (0.128)	+1.385 (0.042)
+1.50 D	Press-On Optics	+1.536 (0.0579)	-0.112 (0.149)	+1.467 (0.09)	+1.473 (0.080)	-0.074 (0.133)	+1.439 (0.069)	+1.486 (0.0717)	-0.062 (0.1337)	+1.455 (0.062)
+2.00 D	OPTX 20/20	+1.87 (0.00)	-0.00 (0.00)	+1.858 (0.038)	+1.87 (0.00)	-0.025 (0.079)	+1.858 (0.038)	+1.871 (0.0589)	-0.0278 (0.833)	+1.858 (0.038)
+2.00 D	Press-On Optics	+2.036 (0.058)	-0.05 (0.158)	+2.011 (0.07)	+1.934 (0.0895)	-0.012 (0.0379)	+1.922 (0.106)	+2.00 (0.00)	-0.01 (0.0361)	+1.994 (0.019)
+2.50 D	OPTX 20/20	+2.50 (0.00)	0.00 (0.00)	+2.50 (0.00)	+2.50 (0.00)	-0.00 (0.00)	+2.50 (0.00)	+2.50 (0.00)	-0.00 (0.00)	+2.50 (0.00)
+2.50 D	Press-On Optics	+2.486 (0.0716)	-0.024 (0.0505)	+2.474 (0.074)	+2.423 (0.0887)	-0.074 (0.1049)	+2.385 (0.088)	+2.422 (0.1057)	-0.0563 (0.128)	+2.392 (0.084)

Table 3. Percentage of segments failing to meet ANSI standards for sphere and cylinder powers. Data were produced by an automated lensometer measuring the center portions of 10 segments for each segment type and power combination.

Marked Power	Segment Type	Percentage Failing to Meet ANSI Standard (N=10)
+1.00	OPTX 20/20™	60
+1.00	Press-On Optics™	20
+1.50	OPTX 20/20™	60
+1.50	Press-On Optics™	40
+2.00	OPTX 20/20™	0
+2.00	Press-On Optics™	10
+2.50	OPTX 20/20™	0
+2.50	Press-On Optics™	0

Table 4. Percentage of Segments With Central Distortion Grades Shown

(Percentages are based on evaluations of 10 segments for each type and power. Only grades 1 through 3 are shown because no segment was graded 4 or 5.)

Marked Segment Power	Segment Type	Percent Grade 1	Percent Grade 2	Percent Grade 3
+1.00	OPTX 20/20™	60	40	0
+1.00	Press-On Optics™	20	70	10
+1.50	OPTX 20/20™	60	40	0
+1.50	Press-On Optics™	60	40	0
+2.00	OPTX 20/20™	80	20	0
+2.00	Press-On Optics™	40	50	10
+2.50	OPTX 20/20™	100	0	0
+2.50	Press-On Optics™	30	70	0

Table 5. Percentage of Segments With Over All Distortion Grades Shown

(Percentages are based on evaluations of 10 segments for each type and power. Only grades 2 through 5 are shown because no segment was graded 1.)

Marked Segment Power	Segment Type	Percent Grade 2	Percent Grade 3	Percent Grade 4	Percent Grade 5
+1.00	OPTX 20/20™	0	0	0	100
+1.00	Press-On Optics™	10	20	50	20
+1.50	OPTX 20/20™	0	20	10	70
+1.50	Press-On Optics™	10	70	20	0
+2.00	OPTX 20/20™	0	30	30	40
+2.00	Press-On Optics™	0	70	20	10
+2.50	OPTX 20/20™	30	70	0	0
+2.50	Press-On Optics™	10	60	30	0

Table 6. Near acuities measured using +2.00 D segment powers.

Segment Type	Mean LogMAR Acuity	Standard Deviation of LogMAR Acuities	Mean LogMAR Acuity Converted to Snellen Equivalent
Molded	-0.063	0.081	20/17
OPTX 20/20™	-0.062	0.077	20/17
Press-On Optics™	-0.006	0.051	20/20

Table 7. Percentages of subjects with at least one line of extrapolated acuity difference between segment types (Only comparisons for which there is a non-zero number of subjects are shown. Total number of subjects = 23.)

Comparison	Percentage of Subjects
Molded CR-39 was better than Press-On Optics™	57
Molded CR-39 was better than OPTX 20/20™	9
OPTX 20/20™ was better than Press-On Optics™	61
OPTX 20/20™ was better than molded CR-39	13
Press-On Optics™ was better than OPTX 20/20™	9

FIGURE LEGENDS

Figure 1. Packaging of OPTX 20/20™ and Press-On Optics™ temporary use bifocal segments.

Figure 2. Photographs through segments illustrating distortion grades. Grade 1 top; grade 5 bottom.

Figure 3. Examples of distortion produced by typical +2.00 D OPTX 20/20™ (top) and Press-On Optics™ (bottom) segments.

Figure 4. Near contrast sensitivity data for +2.00 D CR-39, OPTX 20/20™, and Press-On Optics™ segments.

Figure 1.

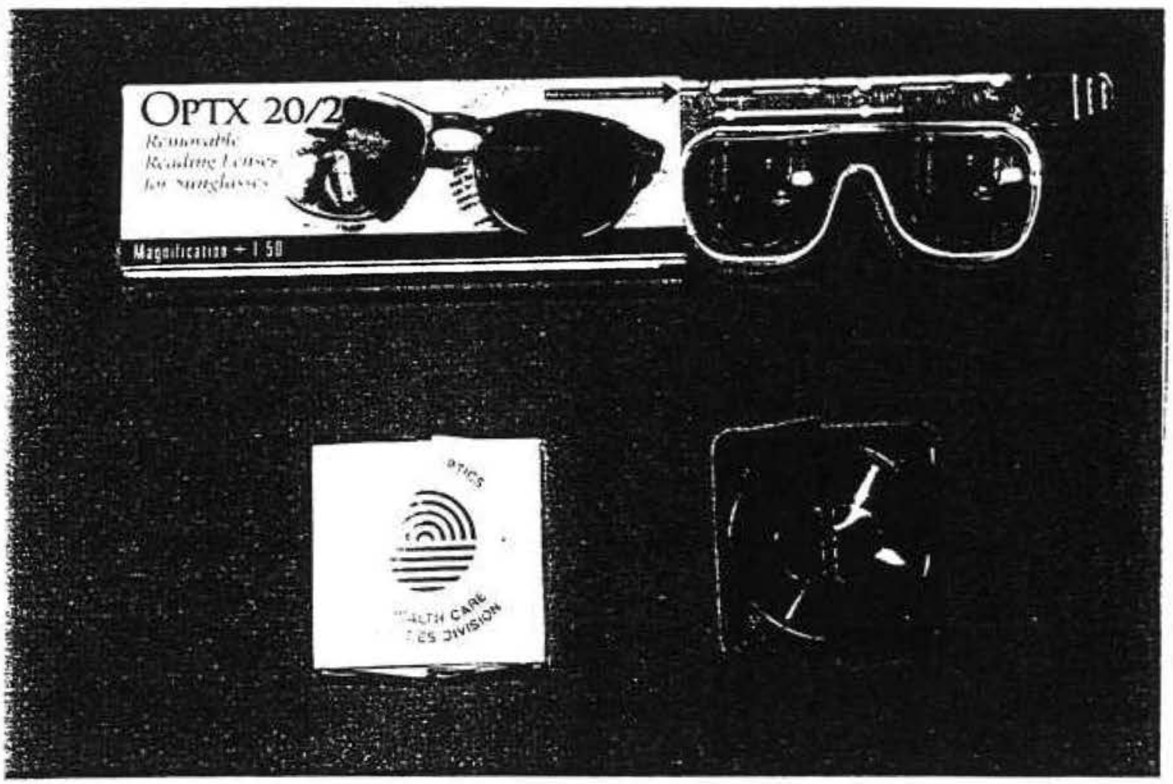


Figure 2.

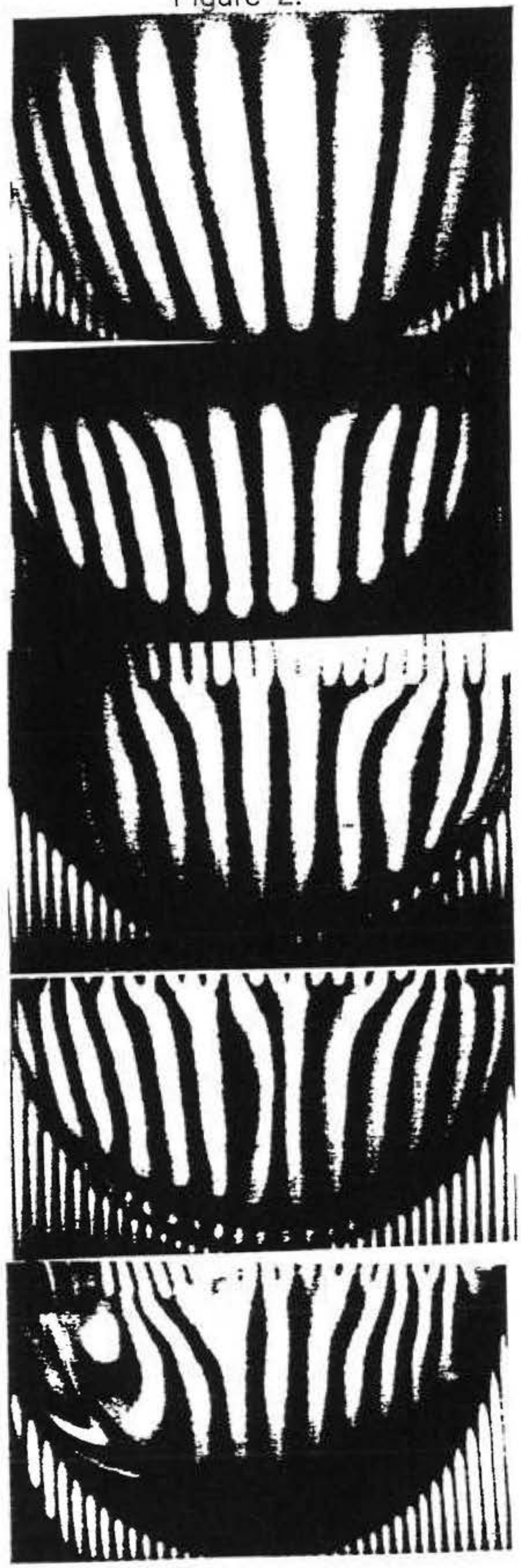
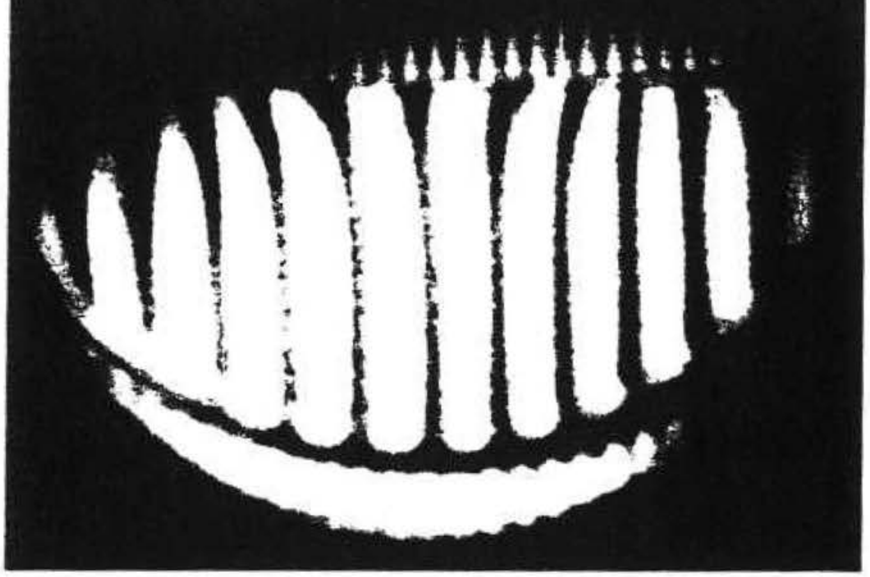


Figure 3.



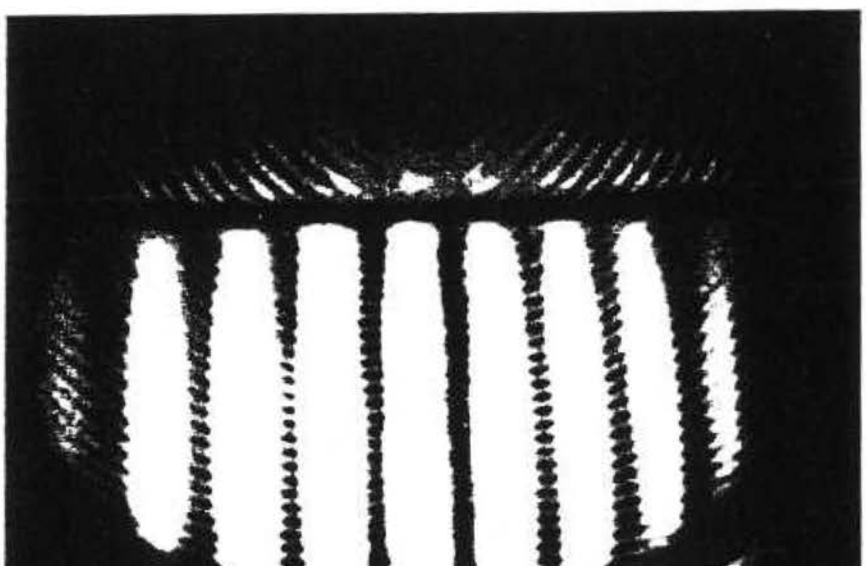
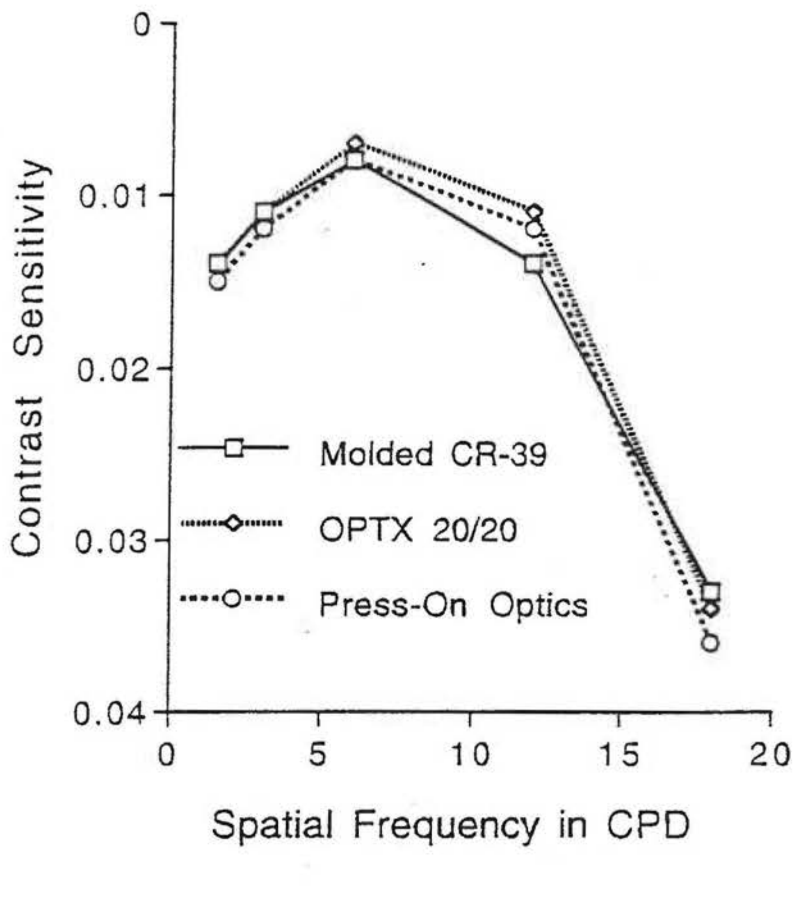


Figure 4.


0
0.01
0.02
0.03
0.04
Contrast Sensitivity
Molded CR-39
OPTX 20/20
Press-On Optics
0
5
10
15
20
Spatial Frequency in CPD